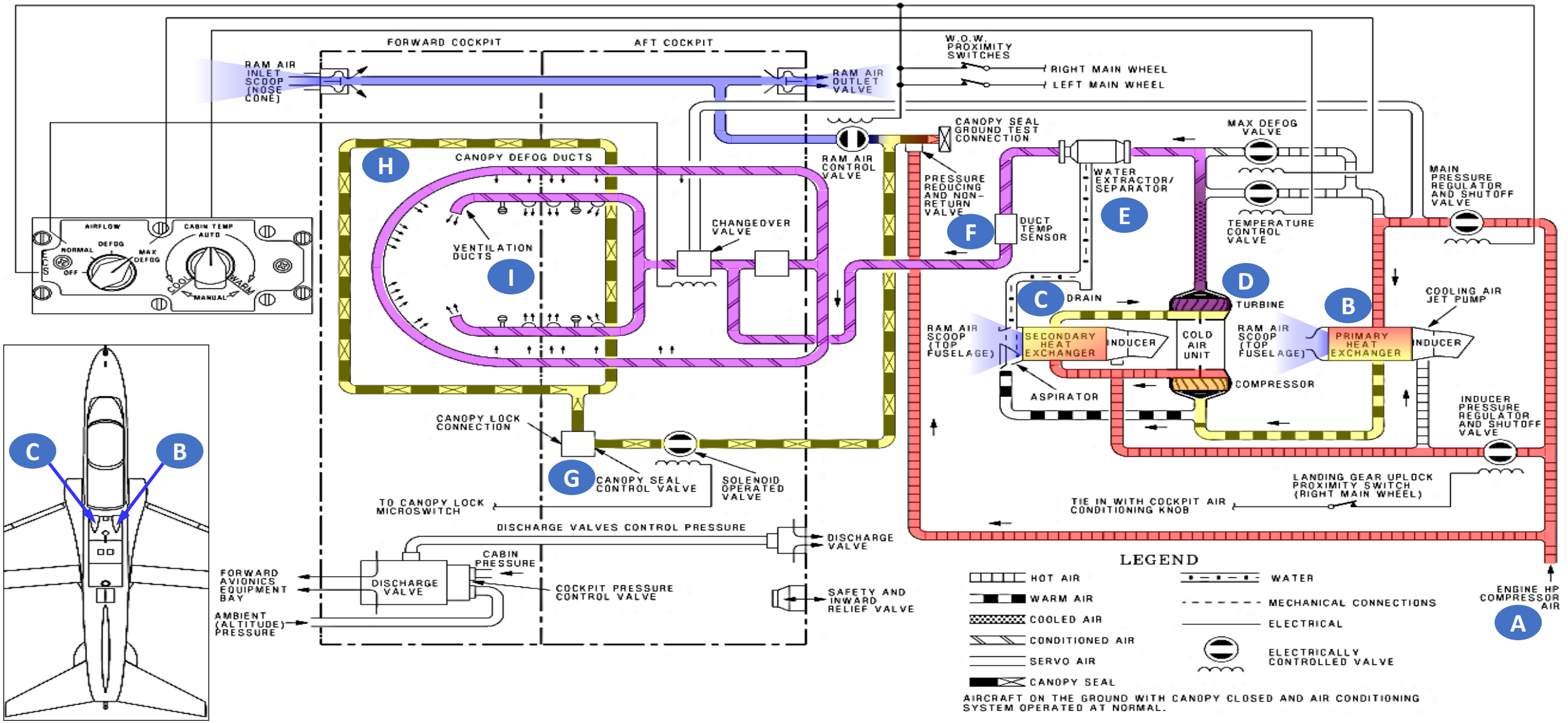
ANNEX F (3): T-45 ECS DIAGRAM AND DESCRIPTION



air leaks; however, in the event a bleed air leak impinges directly on a firewire element, the FIRE warning light may illuminate.

The fire detection system self test is activated by placing and holding the LIGHT TEST/TONE TEST switch, located in both cockpits to the right of the caution/warning panels, in the LIGHT TEST position. The FIRE and GTS FIRE warning lights illuminate to indicate a properly functioning circuit. If the FIRE and GTS FIRE warning lights do not illuminate, system malfunctions are probably caused by short circuits, broken firewire elements or control unit failure.

The tailpipe bay has temperature sensors which activate the TP HOT caution light when bay temperature exceeds 150 °C. The caution light extinguishes when the temperature drops below 150 °C.

2.18 ENVIRONMENTAL CONTROL SYSTEM

The Environmental Control System (ECS) consists of the air conditioning system, the cockpit pressurization system, and avionic equipment cooling system. Air for the cockpit air conditioning and pressurization system is tapped from a port on the final (fifth) stage of the engine compressor. This bleed air is used solely for the environmental control system (temperature control, cockpit pressurization, ram air control, canopy seal, and heat exchanger inducers). Conditioned air is used to cool avionics equipment prior to being vented overboard.

2.18.1 ECS Operation

Refer to Environmental Control System FO-22. The engine supplies bleed air to two solenoid operated pressure regulator valves simultaneously: the Main Pressure Regulating and Shutoff Valve (MPRSOV), and the Inducer Pressure Regulating and Shutoff Valve (IPRSOV). These valves are deenergized open so in the event of loss of all electrical power, the air conditioning and pressurization will remain on. Air from the inducers is used to increase the airflow through the heat exchangers when the landing gear are extended. Upstream of the MPRSOV, bleed air is passed to the canopy seal system and to the control chambers of the ram air inlet and outlet valves. With airflow knob in the OFF position, idle rpm will operate approximately 2 percent higher than normal.

Air from the MPRSOV passes simultaneously to the primary heat exchanger, the temperature control valve, the max defog valve, and provides servo air to the changeover valve. After cooling in the primary heat exchanger, air is supplied to the compressor of the Cold Air Unit (CAU), then to the secondary heat exchanger and finally, to the turbine of the CAU from where the cold air emerges. Leaving the cold air unit, air is ducted through a water separator and then to the cockpits.

(Before AFC-291) The hot air flow supply is primarily controlled by the temperature control valve which opens to allow hot bleed air to bypass the cooling system and to mix with the cold air from the CAU before entering the water separator. The max defog valve directs a larger volume of the hot air to mix with the cold air before being supplied to both canopy and ventilation ducts.

(After AFC-291) The hot air flow supply is controlled by the temperature control valve which opens to allow hot bleed air to bypass the cooling system and to mix with the cold air from the CAU before entering the water separator. The max defog valve is no longer used.

In-flight, ram air is employed for cooling the engine bleed air passing through the heat exchangers. Cooling air enters the aircraft through two ram air scoops located behind the canopy. The scoops are built into a large door, through which access is gained to the heat exchanger/cold air unit assembly and fuselage fuel tank. The cooling air from the heat exchangers passes overboard through holes in the top of the aircraft forward of the GTS.

When the landing gear are extended, cooling air is induced through each heat exchanger by a cooling air jet pump. When either the landing gear is raised or the cockpit air conditioning system is switched off, the jet pumps shut off. In the event of an electrical failure the jet pumps will operate normally.

Within the cockpit, air is distributed by means of two separate sets of ducts: ventilation and defog. The majority of supply air (approximately 60 percent) can be directed to either the ventilation or defog ducts. A changeover valve, located in the supply tube leading to the ventilation/defog ducts is used to control the proportion of the supply air.

Changeover valve position is controlled through the AIR FLOW control knob, which in turn directs servo pressure to position the valve. Air pressure for the servos is supplied from a tap downstream of the MPRSOV.

The crew ventilation ducts are located under the left and right canopy rails and contain head, body (directionally adjustable), and foot louvers. The defog ducts are located at the left and right base of the windscreen and canopy, and are perforated with a series of spray holes.

Ram air inlet and outlet valves are positioned on the cockpit forward and aft bulkheads, respectively, to provide emergency ventilation in-flight when the cockpit air conditioning system is switched off. These valves allow fresh air to remove smoke or uncontrollable fogging from the cockpit. On the ground the valves remain open.

The cockpit air conditioning system is turned on by the AIR FLOW control knob in the forward cockpit. Placing the knob to NORMAL opens the MPRSOV and energizes the changeover valve to increase the air flow to the ventilation ducts (approximately 60 percent to ventilation and 40 percent to defog). Placing the knob at DEFOG deenergizes the changeover valve to increase the air flow to the defog ducts (approximately 60 percent to defog and 40 percent to ventilation).

(Before AFC-291) Selection of MAX DEFOG was originally intended to allow more hot bleed air into the conditioned air flow in order to provide added defog capability. However, the system does not function as intended, and will actually result in a reduction of hot air entering the cockpit. Additionally, when MAX DEFOG is selected, moisture, often in the form of ice pellets, will enter the cockpit through the crew ventilation ducts. This effect is prolonged when flying at lower altitudes in a warm, humid environment.

(After AFC-291) Selection of MAX DEFOG increases the selectable cabin delivery air temperature set point above the normal control range by approximately 10 °C (18 °F), providing added defog capability.

Note

- During penetration, cockpit fogging may occur. Use of the DEFOG setting and an increase in cabin controller temperature is recommended prior to and during descent/penetration.
- (Before AFC-291) Use of MAX DEFOG is not recommended.

2.18.1.1 Temperature Control

The pilot can control the temperature in AUTO, MAX DEFOG (after AFC-291) or MANUAL mode. The AUTO mode is provided as the normal operating mode and the MANUAL mode as a backup.

2.18.1.1.1 AUTO Mode

In the AUTO mode the cabin temperature is automatically regulated by the cabin temperature control. The control monitors cabin temperature and compares the temperature with the CABIN TEMP knob setting. If the temperature is incorrect, the control repositions the temperature control valve appropriately to correct the temperature and then automatically repositions the valve to maintain the temperature. The cabin temperature control also positions the temperature control valve to limit the supply duct air temperature by 2.5 to 75 °C (before AFC-291) or 7 to 80 °C (after AFC-291). The CABIN TEMP knob remains in the selected position.

2.18.1.1.2 MANUAL Mode

In the MANUAL mode cabin temperature is manually controlled by holding the CABIN TEMP knob to COOL or WARM. When the knob is set to either position a control signal is sent to the temperature control valve to open or close the valve. The signal is applied to the valve as long as the knob is held in the COOL or WARM position. When the knob is released the knob will spring back to the center position, discontinuing the control signal to the temperature control valve. The control valve, however, will remain in the last selected position. Small changes should be made when adjusting the temperature, accompanied by a brief waiting period before making any further adjustments. The brief waiting period allows the ECS ducts to heat/cool and the discharge temperature to stabilize. In the MANUAL mode the temperature to the ventilation/defog ducts is not limited and must be manually controlled.

CAUTION

- Extended operation in MANUAL mode with very cool temperature selected may result in freeze-up condition of the water separator coalescer and premature failure of the internal coalescer bypass relief valve.
- Extended operation in the MANUAL mode with WARM selected may cause excessive temperatures resulting in weakening or damage of the windscreen.

2.18.1.1.3 MAX DEFOG Mode (After AFC-291)

In MAX DEFOG mode, the AUTO mode operational characteristics are retained, except the selectable cabin delivery air temperature set point is increased above the normal control range available in AUTO mode by approximately 10 °C (18 °F). The cabin temperature control positions the temperature control valve to limit the supply duct air temperature (17 to 90 °C).

2.18.2 Cockpit Pressurization System

Cockpit pressurization is controlled by the pressure control valve and its slave discharge valve. These two servo controlled discharge valves restrict the discharge of air from the cockpit to maintain cockpit pressure at the required differential. Pressurization commences with weight-off-wheels and increases approximately linearly with altitude until the full differential pressure of 4 psi is attained at 40,000 feet MSL. Cabin altitude may be as much as 2,000 feet below aircraft altitude from MSL up to an aircraft altitude of 5,000 feet.

In the event of cockpit pressure control system failure, a safety relief valve ensures that cockpit differential pressure cannot exceed 4.8 psi. The safety valve also incorporates a negative pressure relief function to ensure that a negative cockpit differential pressure cannot exceed 0.5 psi, for example, during a rapid descent. If cockpit pressure is lost, the CABIN ALT warning light illuminates when the cockpit altitude exceeds 24,500 ±500 feet. Refer to Figure 2-43 for the cockpit pressurization schedule.

The pneumatically operated canopy seal has a control valve that is mechanically coupled into the canopy locking mechanism. Air for the seal is tapped from the bleed air supply upstream of the MPRSOV.

2.18.3 Avionic Equipment Cooling System

During flight, cockpit air exhausts through the cockpit pressure control valve and discharge valve. Some of this air passes through the avionics compartments on its way to being discharged aft of the air conditioning equipment bay.

The AV HOT caution light is only operative on the ground and illuminates if the air temperature in the auxiliary equipment bay exceeds 67 °C.

ECS conditioned air flows to the cockpit ventilation ducts at all times during ground operation for pilot comfort.

2.18.4 ECS Controls and Indicators

2.18.4.1 AIR FLOW Control Knob

The AIR FLOW control knob is located in the front cockpit, on the right console. The knob has the following positions:

OFF	Secures ECS. Opens ram air valves.
NORMAL	Directs approximately 60 percent of the total air flow to the crew ventilation ducts.
DEFOG	Directs approximately 60 percent of the total air flow to the windscreen and canopy defog ducts.

2.18.5.2 AV HOT Caution Light

The AV HOT caution light is located, on the warning/caution/advisory lights panel, on the right side of the instrument panel. The light illuminates when the air temperature in the auxiliary equipment bay exceeds approximately 67 °C. The light only comes on when the aircraft is on the ground.

Figure 2-43. Cockpit Pressurization Schedule